

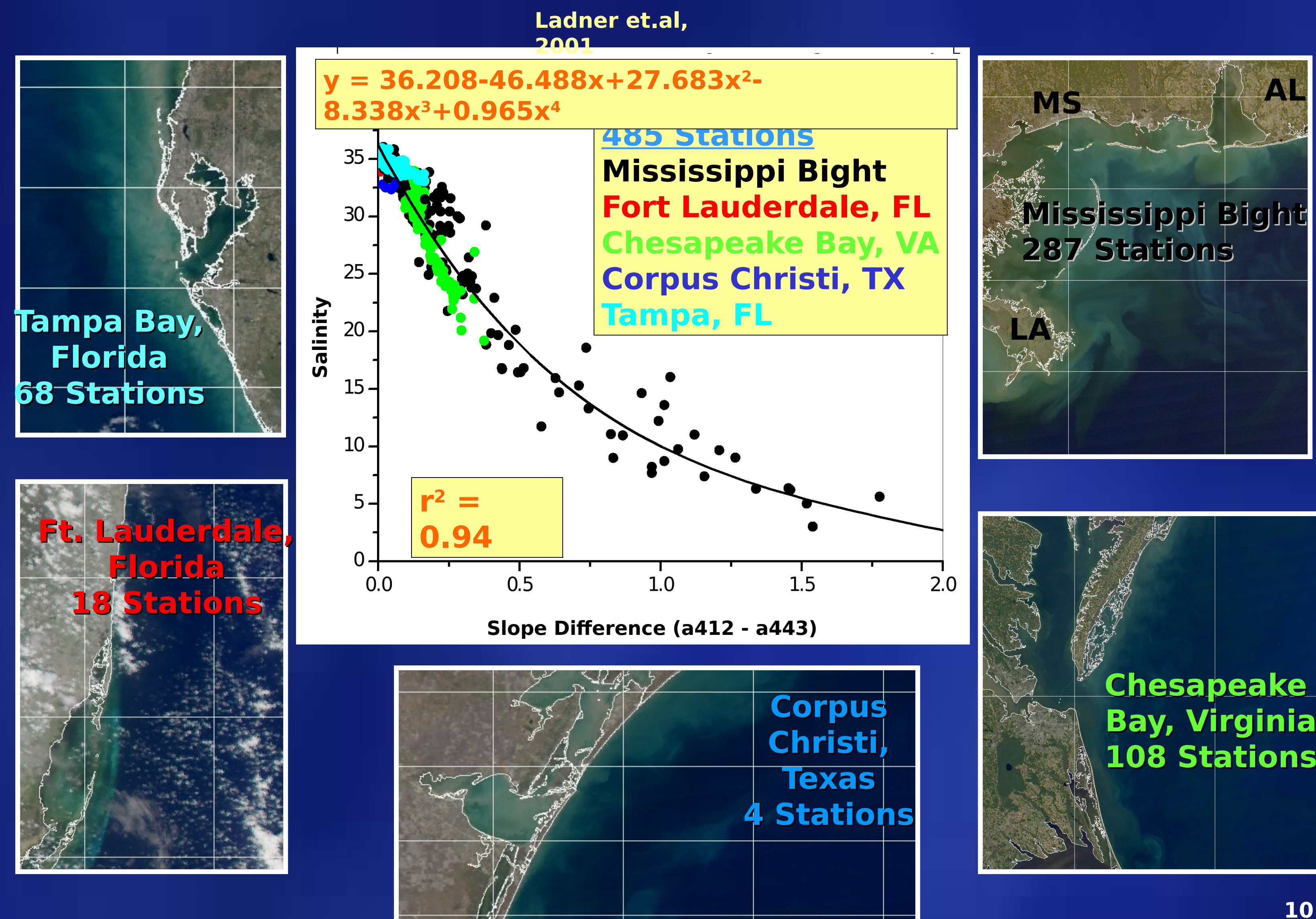
## I. Abstract

In coastal areas dominated by river discharge, bio-optical properties can be used as pseudo-conservative tracers of salinity. Empirical relationships between surface salinity and the optical absorption coefficients were developed using 485 shipboard measurements collected in U.S. Waters (Mississippi Sound, Mobile Bay, Fort Lauderdale, New York Bight, Chesapeake Bay, Corpus Christi) with salinities ranging between 2 - 37 PSU. River and bay discharge plumes are clearly visible in the optical remote sensing imagery. We use the satellite optical products to track plume extent, temporal and spatial variability, mixing dynamics between low-salinity estuarine waters and high-salinity offshore waters, and cross-shelf exchange in the northern Gulf of Mexico. We first apply existing optical algorithms to estimate absorption coefficients from MODIS and SeaWiFS ocean color imagery at 412 and 443 nanometers, then we apply the optical/salinity relationship to produce sea surface salinity estimates from MODIS Aqua and SeaWiFS at 1 kilometer resolution. Satellite-derived coastal salinity estimates are evaluated against an independent set of in situ measurements to validate the algorithm and assess temporal and spatial variability in the northern Gulf of Mexico. Inter-annual variability in the salinity/optical relationships is characterized using coastal mooring data, to determine whether the satellite algorithms are universally applicable across season and geographic region.

## II. Objectives

- 1 Develop relationship between salinity and optical absorption coefficients from insitu data.
- 2 Evaluate satellite-derived absorption values and apply algorithm correction.
- 3 Evaluate satellite-derived salinity using independent data sets collected at 5 mooring sites in the Northern Gulf of Mexico.
- 4 Assess inter-annual and spatial variability in the salinity/optical relationships using coastal mooring data collected over entire annual cycle (2003) to determine whether the relationships are applicable across season and geographic region.

## III. Salinity Algorithm Development From Shipboard Measurements



Note: In-water absorption coefficients were measured using a WetLabs Absorption and Beam Attenuation meter (AC9) at nine wavelengths while the salinities were measured using a SeaBird Conductivity and Temperature sensor (CTD).

## Presentation #: OS25R-18 Using Ocean Color Imagery to Monitor Salinity in the Northern Gulf of Mexico

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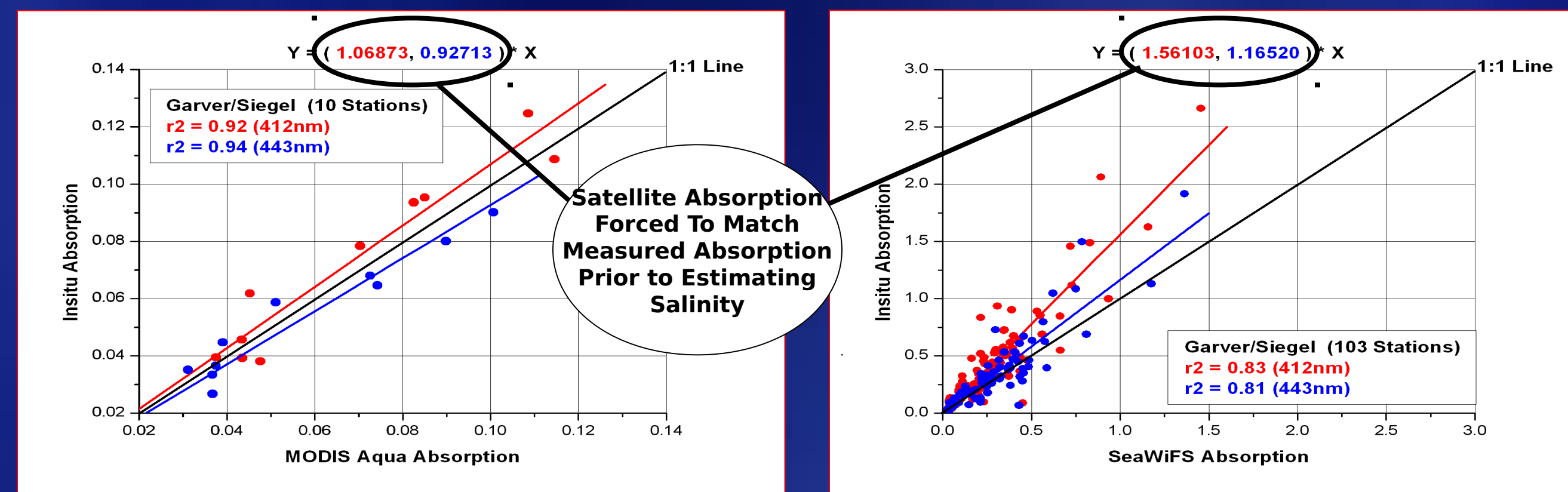
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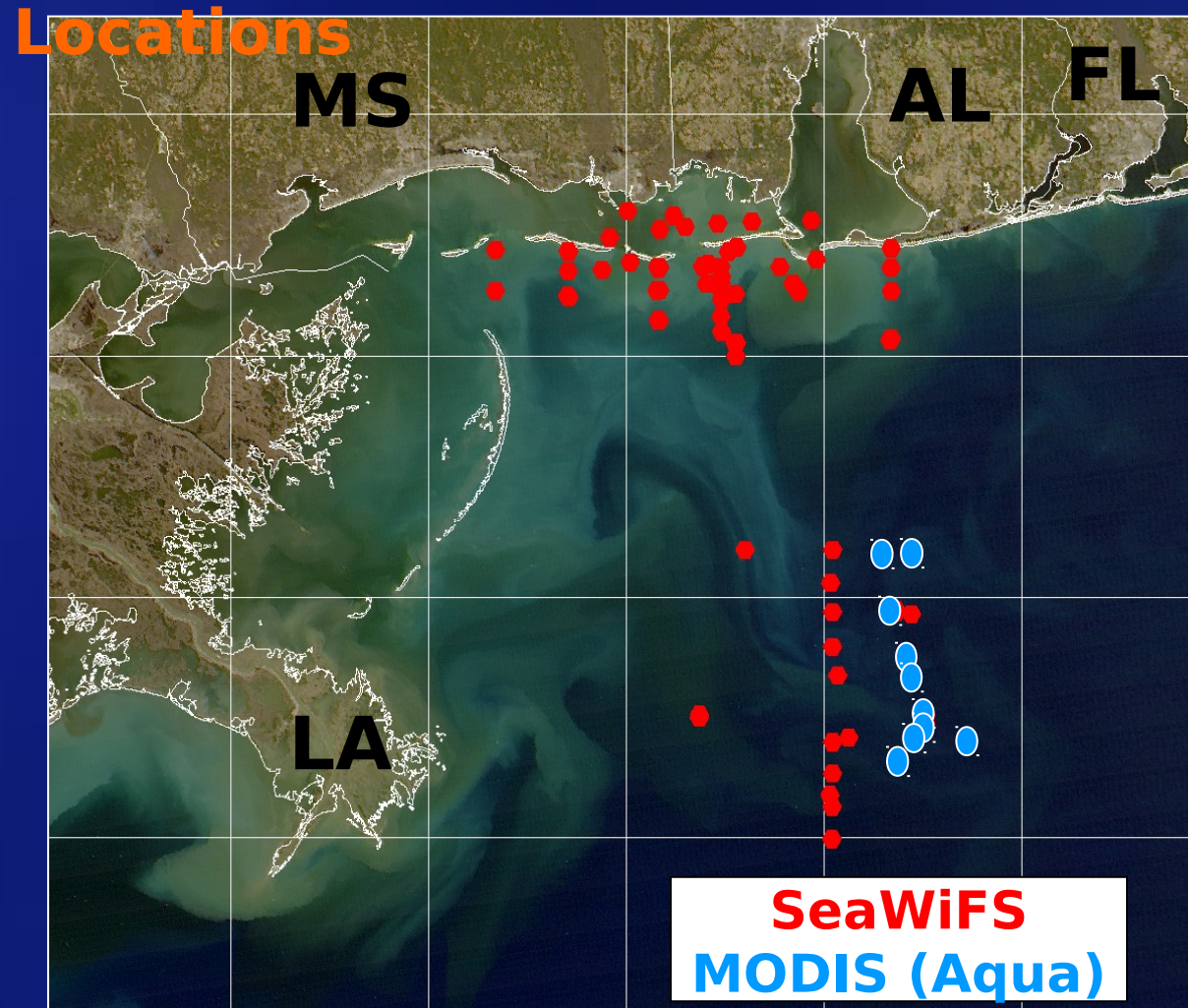
## IV. Satellite Algorithm Evaluation / Adjustment of Absorption Coefficients



Note: Satellite Absorption Coefficients were estimated using the Garver and Siegel 2001 (GSM01) algorithm contained in the SeADAS Version 4.8 processing package wrapped inside of NRL's Automated Processing System (APS). Derived Absorption coefficients are very close to the measured values collected in the Mississippi Bight region (Station Map Below). The MODIS coefficients are closer to the 1:1 line in the plot on the left (Errors less than 8%). MODIS 412nm and SeaWiFS 412 and 443 nm absorptions are slightly over-estimated. SeaWiFS 412nm values have the largest errors (<50%). The derived satellite absorption values were forced to match measured values before salinity was estimated.

### Satellite Algorithm Validation

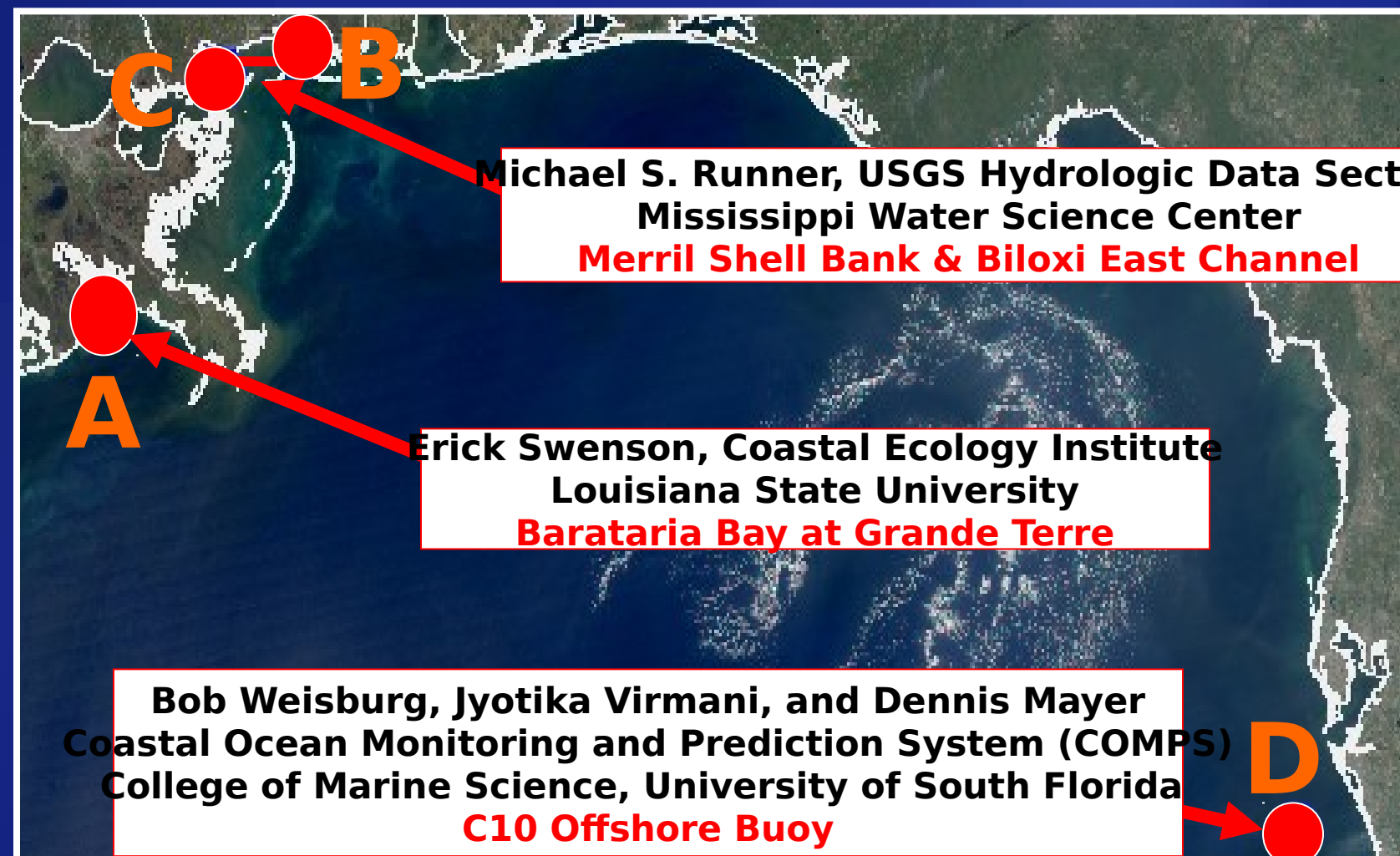
(a)



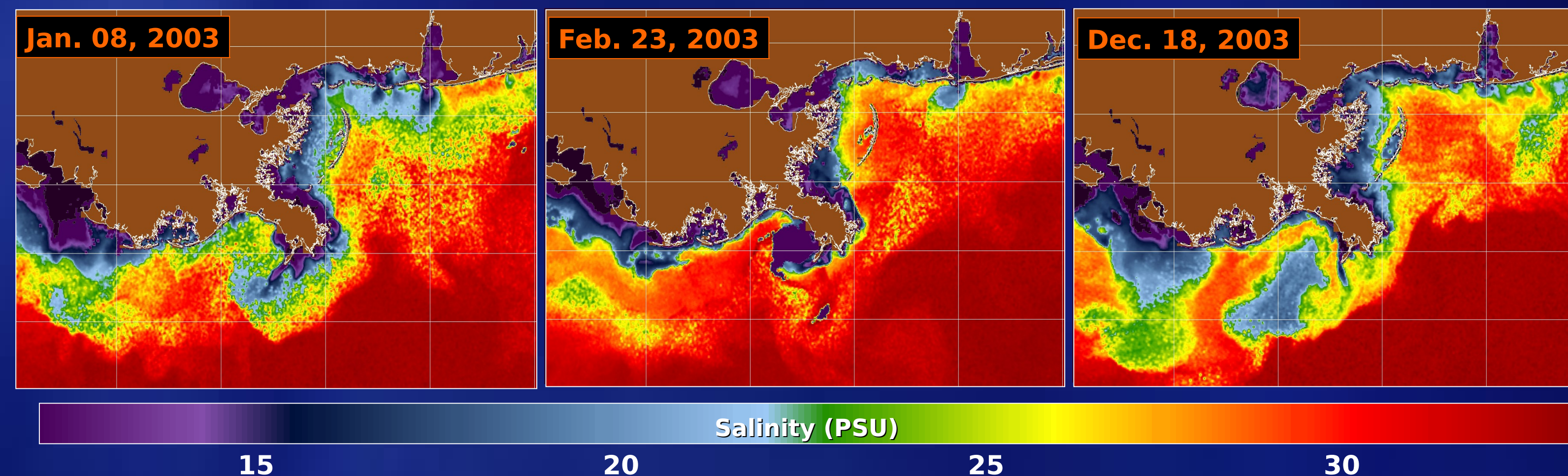
Note: (a) Validation stations were collected inside the Mississippi Bight region during the 2002-2003 COJET and the 2004-2005 SEED surveys. (b) Three mooring locations near Barataria Bay, Louisiana and Bay St. Louis and Biloxi, Mississippi are near riverine outflows and the other is located on the Florida Shelf near Tampa Florida.

### Time Series Mooring Locations

(b)

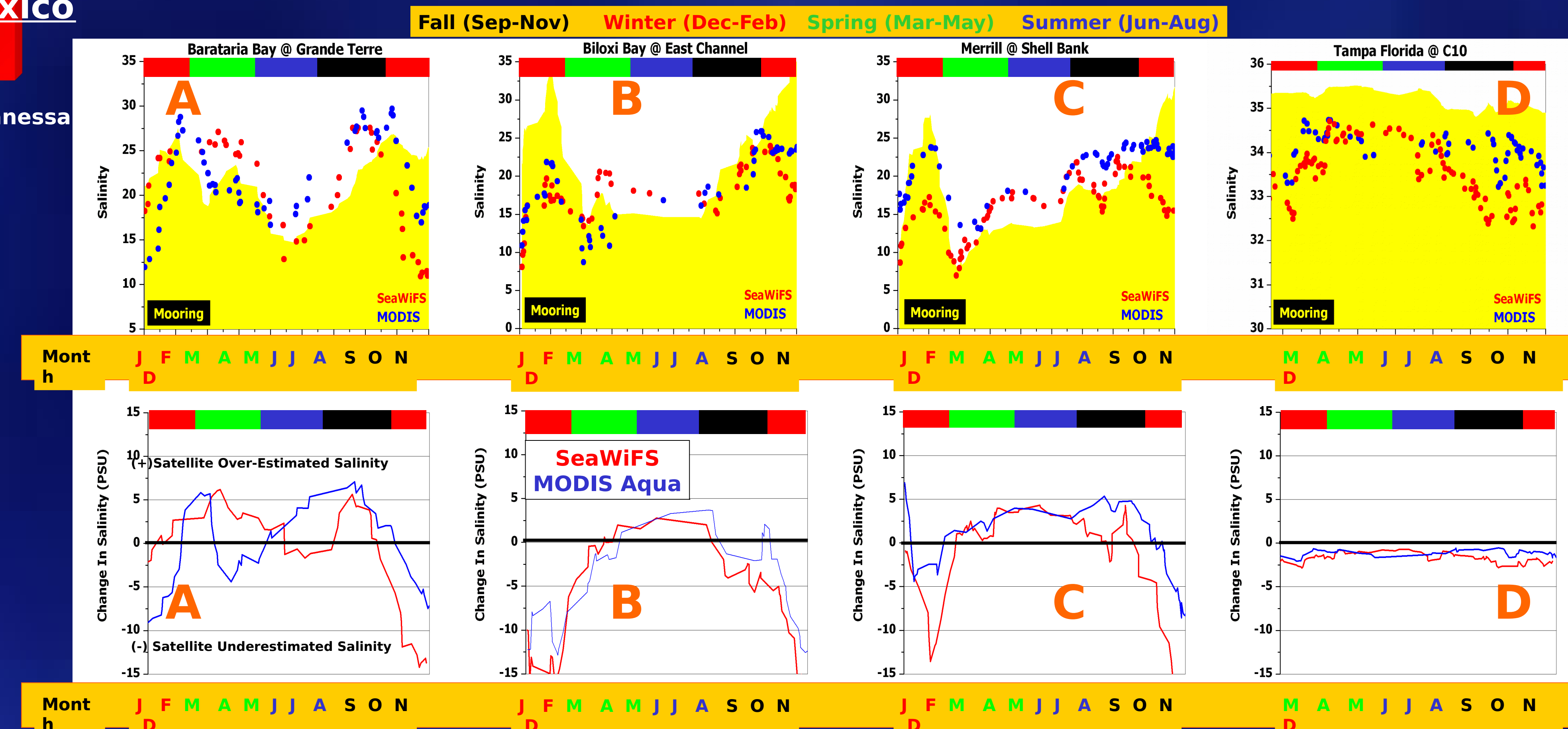


## V. Real-Time SeaWiFS Salinity

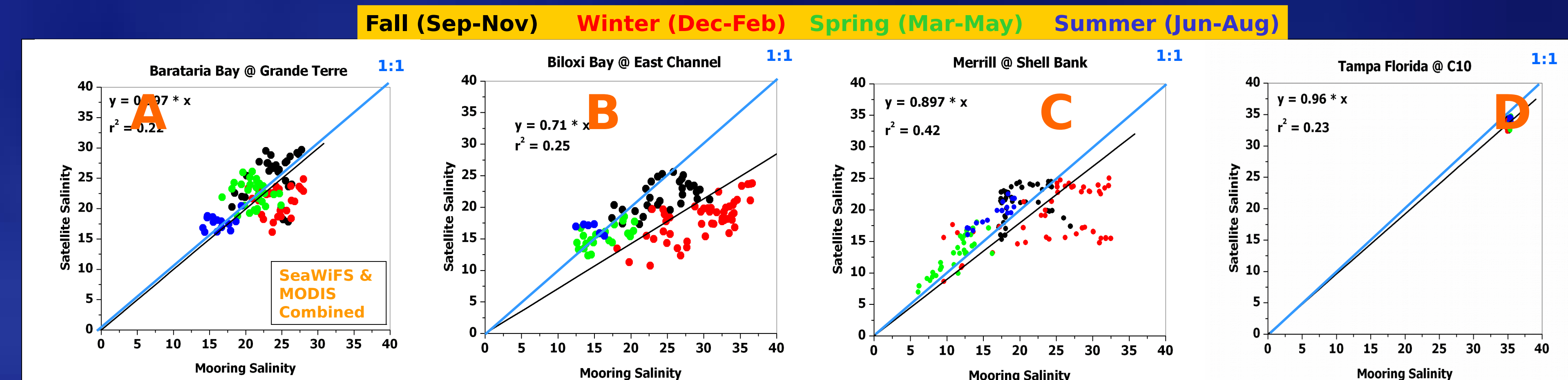


Note: Low salinity waters are trapped off the coast of Louisiana near Barataria Bay and the Atchafalaya Basin. Major Fresh Water outflow occurs during these winter months.

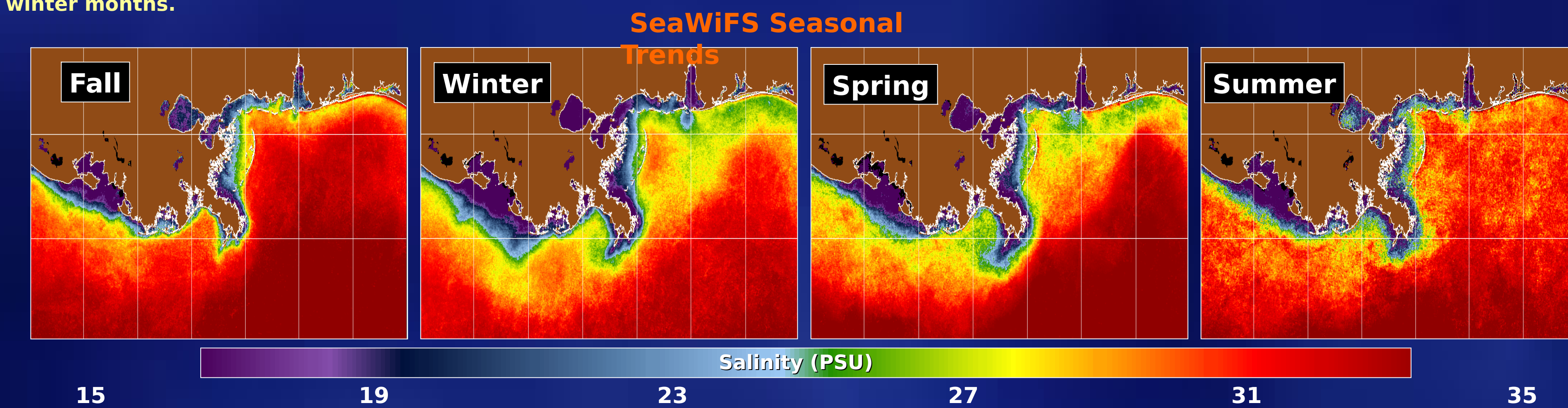
## VI. Satellite vs. Measured Salinity for Jan-Dec 2003 in the Gulf of Mexico



Note: For Barataria, the derived salinities are estimated within 6 PSU's between February and November and up to 15 PSU's for December and January. For Biloxi, the derived salinities are estimated within 5 PSU's between March and November and up to 15 PSU's for December, January and February. For Merrill derived salinities are estimated within 5 PSU's for January and between March and November and up to 15 PSU's for December and February. For Tampa, all months are estimated within 3 PSU's and the satellite derived salinities are underestimated for all months. For Barataria, Biloxi, and Merrill the satellite derived values are underestimated in the fall and winter months and over-estimated the majority of the time in the spring and summer.



Note: For Barataria, Biloxi, and Merrill Locations, the derived salinities are much closer (within 5-6 PSU's) to measured salinities during the Spring, Summer, and Fall. The Winter season yields higher variations. For Tampa, the all seasons yield similar results that are much closer to satellite estimates (within 3 PSU's). Slopes are close to 1:1 line for all locations except Biloxi Bay. R-Squared values are low due to winter months.



## VII. Summary

- 1 Determined 4<sup>th</sup> Power Polynomial Fit for surface salinity and absorption slope (412-443) from insitu data ( $r^2 = 0.94$ ).
- 2 Applied the salinity algorithm to SeaWiFS and MODIS imagery. Satellite-derived salinity values were within 5 PSU's at mooring locations during the fall, spring and summer and within 15 PSU's during the winter.
- 3 Salinity algorithm underestimated salinity in the winter months

## Reference

Ladner, S.D., R.W. Gould, Jr., R.A. Arnone, D.R. Johnson, and W. Snyder. "Estimating salinity from CDOM absorption off coastal New Jersey", TOS 2001 (Poster)